What is Claimed:

1. A method for laser welding a first foil to a second foil, the method comprising the steps of:

a) providing the first foil having a first thickness and the second foil having a second thickness, the second thickness being less than about 150% of the first thickness;

b) positioning at least a portion of a bottom surface of the first foil in contact with at least a portion of a top surface of the second foil;

c) producing a beam spot on a top surface of the first foil using a laser welding system, at least a central region of the beam spot having sufficient fluence to form a melt pool that extends from the top surface of the first foil to the bottom surface of the first foil; and

d) scanning the laser beam spot along a weld line of the top surface of the first foil to weld the first foil to the second foil along the weld line.

2. A method according to claim 1, wherein step (a) includes the steps of:

a1) providing the first foil formed of at least of steel, aluminum, copper, gold, silver, molybdenum, tungsten, iron, tantalum, nickel, a polymer material, or a plastic material;

a2) providing the second foil formed of at least of steel, aluminum, copper, gold, silver, molybdenum, tungsten, iron, tantalum, nickel, a polymer material, or a plastic material.

3. A method according to claim 1, wherein step (b) further includes the step of positioning a thermally conductive top-plate in contact with the top surface of the first foil proximate to the weld line.

4. A method according to claim 1, wherein step (c) includes the steps of:

c1) generating a continuous wave laser beam, the continuous wave laser beam having a predetermined wavelength and a welding power; and

c2) focusing the continuous wave laser beam to the beam spot on the top surface of the first foil having a welding spot size.

5. A method according to claim 4, wherein:

step (c2) includes coupling the continuous wave laser beam into a fiber-coupled laser head; and

step (d) includes moving the fiber-coupled laser head parallel to the top surface of the first foil to scan the beam spot along the weld line.

6. A method according to claim 4, wherein step (d) includes scanning the beam spot along the weld line at a welding slew rate.

7. A method according to claim 6, wherein step (d) includes one of:

moving the first foil and the second foil at the welding slew rate so that the beam spot is scanned along the weld line on the top surface of the first foil; or

moving the beam spot at the welding slew rate so that the beam spot is scanned along the weld line on the top surface of the first foil.

8. A method according to claim 6, wherein step (d) includes the steps of:

d1) detecting a temperature of the first foil proximate to the weld line; and

d2) varying the welding slew rate based on the temperature detected in step (d1).

9. A method according to claim 6, wherein:

the weld line extends from a first edge of the first foil to a second edge of the first foil;

step (d) includes varying the slew rate in portions of the weld line proximate to the first edge of the first foil and the second edge of the first foil.

10. A method according to claim 4, wherein step (c1) includes the steps of:

c1a) detecting a temperature of the first foil proximate to the weld line; and

c1b) varying at least one of the welding power and the welding spot size based on the temperature detected in step (c1a).

11. A method according to claim 4, wherein:

the weld line extends from a first edge of the first foil to a second edge of the first foil;

step (c1) includes varying at least one of the welding power and the welding spot size in portions of the weld line proximate to the first edge of the first foil and the second edge of the first foil.

12. A method according to claim 1, wherein:

step (b) includes at least one of:

placing the first foil and the second foil in a process gas; or

blowing the process gas over the at least a portion of the first foil proximate to the beam spot; and

the process gas is selected to reduce ambient chemical reactions of a material of the first foil during laser welding.

13. A method according to claim 12, wherein the process gas includes at least one of nitrogen, carbon dioxide, or a noble gas.

14. A system for laser welding a plurality of foils arranged in a stack, the system comprising:

a continuous wave laser for generating a laser beam;

optics for focusing the laser beam to a beam spot;

a foil holder including a thermally conductive plate that includes a continuous edge, the thermally conductive plate placed in contact with a top surface of a first foil of the plurality of foils to hold the plurality of foils such that the continuous edge is proximate to a weld line; and

a movement stage for scanning the beam spot of the laser beam along the weld line at a welding slew rate by moving at least one of;

the foil holder and the plurality of foils; or

the optics.

15. A system according to claim 14, wherein the foil holder further includes:

a temperature sensor thermally coupled to at least one of the plurality of foils for sensing a foil temperature proximate to the weld line; and

a controller for varying one or more of the welding slew rate and a power of the laser beam responsive to the foil temperature.

16. A system according to claim 15, wherein:

the thermally conductive plate includes a void proximate to the continuous edge; and

the temperature sensor includes a thermocouple placed within the void.

17. A system according to claim 14, wherein the continuous edge of the thermally conductive plate is sloped at an acute angle relative to the top surface of the first foil sloping away from the weld line.

18. A system according to claim 14, wherein the optics include an optical fiber and an output laser head.

19. A system according to claim 18, the movement stage includes an arm for positioning the output laser head such that the beam spot of the laser beam is focused and scanned along the weld line from a predetermined position relative to the first foil.

20. A system according to claim 14, wherein the continuous wave laser is a high power direct diode laser operated at a wavelength of approximately 808nm and a power of between about 150 and 200 watts.

21. A system according to claim 14, wherein the continuous wave laser is operated at a wavelength selected to be substantially absorbed by the first foil.

22. A system according to claim 21, wherein the continuous wave laser is operated at a wavelength selected to be substantially reflected by the continuous edge of the thermally conductive plate.

23. A system according to claim 14, further comprising a process gas injector for one or more of:

blowing a process gas over the weld line in a region including the beam spot; or

surrounding the plurality of foils with the process gas.

24. A system according to claim 14, wherein the plurality of foils include at least one of steel, aluminum, copper, gold, silver, molybdenum, tungsten, iron, tantalum, nickel, a polymer material, or a plastic material.

25. A system according to claim 14, wherein the thermally conductive plate includes at least one of copper, ceramic, or alumina.

26. A system according to claim 14, wherein:

a body of the thermally conductive plate is substantially formed of copper; and

the continuous edge of the thermally conductive plate is substantially formed of alumina.

27. A method for laser welding a first foil to a second foil, the method comprising the steps of:

a) providing the first foil having a first thickness and the second foil having a second thickness;

b) positioning at least a portion of a bottom surface of the first foil in contact with at least a portion of a top surface of the second foil;

c) positioning a thermally conductive plate including a continuous edge, a bottom surface of the thermally conductive plate being in contact with at least a portion of a top surface of the first foil;

d) producing a beam spot on the top surface of the first foil using a laser welding system, at least a central region of the beam spot having sufficient fluence to form a melt pool that extends from the top surface of the first foil to the bottom surface of the first foil; and

e) scanning the laser beam spot along a weld line of the top surface of the first foil to weld the first foil to the second foil along the weld line, the weld line being proximate to the continuous edge of the thermally conductive plate.

28. A method according to claim 27, wherein the first thickness is greater than or equal to the second thickness.

29. A method according to claim 27, wherein:

step (a) further includes providing a third foil having a third thickness;

step (b) further includes positioning at least a portion of a bottom surface of the second foil in contact with at least a portion of a top surface of the third foil; and

the sum of the second thickness and the third thickness being less than about 150% of the first thickness.

30. A method according to claim 27, wherein step (a) includes the steps of:

a1) providing the first foil formed of at least one of steel, aluminum, copper, gold, silver, molybdenum, tungsten, iron, tantalum, nickel, a polymer material, or a plastic material;

a2) providing the second foil formed of at least one of steel, aluminum, copper, gold, silver, molybdenum, tungsten, iron, tantalum, nickel, a polymer material, or a plastic material.

31. A method according to claim 27, wherein step (d) includes the steps of:

d1) generating a continuous wave laser beam, the continuous wave laser beam having a predetermined wavelength and a welding power; and

d2) focusing the continuous wave laser beam to the beam spot on the top surface of the first foil having a welding spot size.

32. A method according to claim 29, wherein:

step (d2) includes coupling the continuous wave laser beam into a fiber-coupled laser head; and

step (e) includes moving the fiber-coupled laser head parallel to the top surface of the first foil to scan the beam spot along the weld line.

33. A method according to claim 29, wherein step (e) includes scanning the beam spot along the weld line at a welding slew rate.

34. A method according to claim 33, wherein step (d) includes one of:

moving the first foil, the second foil, and the thermally conductive plate at the welding slew rate so that the beam spot is scanned along the weld line on the top surface of the first foil; or

moving the beam spot at the welding slew rate so that the beam spot is scanned along the weld line on the top surface of the first foil.

35. A method according to claim 33, wherein step (e) includes the steps of:

e1) detecting a temperature of the first foil proximate to the weld line; and

e2) varying the welding slew rate based on the temperature detected in step (e1).

36. A method according to claim 33, wherein:

the weld line extends from a first edge of the first foil to a second edge of the first foil;

step (e) includes varying the slew rate in portions of the weld line proximate to the first edge of the first foil and the second edge of the first foil.

37. A method according to claim 29, wherein step (d1) includes the steps of:

d1a) detecting a temperature of the first foil proximate to the weld line; and

d1b) varying at least one of the welding power and the welding spot size based on the temperature detected in step (d1a).

38. A method according to claim 29, wherein:

the weld line extends from a first edge of the first foil to a second edge of the first foil;

step (d1) includes varying at least one of the welding power and the welding spot size in portions of the weld line proximate to the first edge of the first foil and the second edge of the first foil.

39. A method according to claim 27, wherein:

step (b) includes at least one of:

placing the first foil and the second foil in a process gas; or

blowing the process gas over the at least a portion of the first foil proximate to the beam spot; and

the process gas is selected to reduce ambient chemical reactions of a material of the first foil during laser welding.

40. A method according to claim 39, wherein the process gas includes at least one of nitrogen, carbon dioxide, or a noble gas.